

UNIDAP.

**Universally Adaptable
Research Data Systems**

DATA-CONTROL SYSTEMS, INC.

Instrumentation for Research



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Home Office: E. Liberty St., Danbury, Conn. • 743-9241 Area Code 203 • TWX: 203-744-1999

UNIDAP RESEARCH DATA SYSTEMS

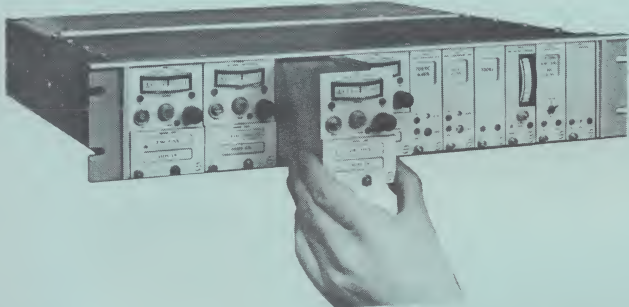
UNIDAP.

A New Design Concept!

This modular building block concept has been developed by DCS to permit synthesis of data systems through integration of readily available instrumentation components and proven techniques. These "all solid-state" modules provide state-of-the-art performance along with high reliability operation.

A wide variety of circuit modules permits the system designed to proceed rapidly and confidently from block diagram to system fabrication. The user's own special circuit designs can be quickly incorporated into "block" modules by DCS or the user. Modification of the electrical and physical configuration of a system can be readily accomplished by the interchange, substitution, and addition of circuit modules.

All UNIDAP units are designed to mount in a basic modular housing which provides a variety of power supply voltages and self-contained blower for proper cooling and ventilation.



UNIDAP Model GMA-1 Modular Assembly with four GFD-5 Discriminators and other UNIDAP components. Modular Assembly contains integral power supply and cooling facilities for all components.

BASIC APPLICATIONS OF UNIDAP

Most UNIDAP applications involve, but are not limited to, analog data handling systems which employ large numbers of information channels. The information may be encoded, converted, translated, multiplexed, transmitted, stored, reproduced and demodulated.

Here are some typical systems applications and problems best satisfied by the use of UNIDAP.

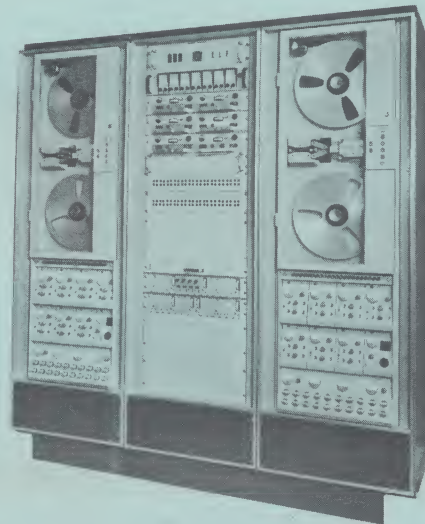
Launch Instrumentation Transmission System

Modern large space booster launch and static test facilities require the accumulation, storage, and monitoring of many (typically more than 100) channels of vibration and other high-frequency transient phenomena. This data is accumulated at the test site but, for safety reasons, must be transmitted by land line thousands of feet and sometimes miles to a central data and control center. These land lines usually provide bandwidths up to 1 mc.

Constant bandwidth FM multiplex systems made up entirely of standard UNIDAP modules readily solve this problem. Both low and high level signals modulate FM oscillators and, through frequency translation and linear mixing, are spectrally combined to make the most effective use of the available transmission bandwidth. At the terminal location, the carriers are separated in groups or singly for storage on magnetic tape and may be demodulated and displayed if required. Typically 10 channels of data are recorded on each track but as many as 20 or 30 can be accommodated in order to have all channels recorded on the same tape. Such systems can provide individual data channel accuracies well in excess of 1% with microsecond time-correlation between channels.

Predetection Systems

Many present day Telemetering Systems require provisions for recording the received signal without first demodulating it. This is accomplished by heterodyning the IF output from the receiver down to an IF frequency at or below one megacycle so that it can be magnetically recorded. Standard UNIDAP Modules accomplish this process which is generally called down-conversion. The first Module (Model GLF-1) limits and bandpasses the receiver IF signal to establish the desired predetection bandwidth. A second module (Model GXO-2) is a crystal controlled oscillator which provides the precise local oscillator signal and determines the band center. The third module (Model GIC-1) is the IF Converter which carries out the heterodyning process. These units are supplied by DCS as component parts of complete predetection systems or as components which can be used with nearly all existing receivers and magnetic recorders. In addition DCS offers the only wide band, solid state, phase locked loop discriminator available today for demodulating the predetection signal as recorded and without the necessity for up-conversion.



A DCS Predetection System utilizing two tape recorders for continuous operation over extended periods of time.

Portable Systems

All UNIDAP components are solid state, compact modules which are mounted in the Model GMA-1 Module Assembly. The Module Assembly provides a power supply which will operate from either 60 cycle or 400 cycle 115 VAC or 28 VDC. The small size, light weight systems, which can be synthesized from the wide variety of available units, are ideal for use in mobile applications such as vans, aircraft and shipboard use. In addition, a complete FM demodulation complex with the capability of simultaneously demodulating over 21 channels with tape speed compensation can easily be carried by hand, or larger systems can be mounted on rollers for use in various areas of a facility. A VCO complex can be changed to a discriminator complex with a minimum of effort and time. This capability allows the basic Module Assembly to be used for many different types of systems without the expenditures normally associated with system reconfigurations.

BASIC PRINCIPLES OF UNIDAP MULTIPLEXED FM RESEARCH DATA SYSTEMS

UNIDAP FM research data systems are designed for the purpose of realizing the full bandwidth capabilities of magnetic recording equipment. This objective is accomplished by converting a number of analog voltage signals to frequency modulated (FM) carriers, and combining these carriers into an FM multiplex whose maximum frequency falls within the bandwidth of the tape recorder.

Multiplex FM techniques also make it possible to acquire and record large numbers of data signals of widely varying frequency on the same tape track.

The use of frequency modulated carriers to record the data presents four important advantages:

- Many FM channels can be multiplexed, providing simultaneous demodulation of an extremely large number of channels.
- The system is highly linear with DC response which permits the recording of static as well as dynamic data.
- Signal amplitude variations introduced by transmission or by the record/reproduce process are greatly minimized, increasing data accuracy.
- Tape speed variations (wow and flutter) can be compensated automatically and accurately.

IRIG FM MULTIPLEXING

The IRIG* standard multiplex consists of constant percentage deviation channels. The sub-carrier is deviated $\pm 7.5\%$ of center frequency for channels 1 through 18 and $\pm 15\%$ of center frequency for channels A through E. The center frequencies of channels A through E are the same as channels 14 through 18. Adjacent channels must be omitted when utilizing the wide deviation

channels to eliminate interference and crosstalk (See IRIG table). The center frequencies used range from 400 cps to 70kc. Considering the maximum deviation for the upper channel, this results in a frequency spectrum from 370 cps to 80,500 cps. Guard bands between channels have been wisely chosen. Intelligence frequencies with a modulation index of 5 are most generally planned for the various channels, although modulation indices to 1 have been used with the expected increase in noise. Assuming a modulation index of 5 for such a system provides various intelligence frequencies from 6 cps for

Channel	Center Frequency (cps)	Deviation (cps)	LIMITS		MAXIMUM INTELLIGENCE FREQUENCY	
			Lower (cps)	Upper (cps)	(Modulation Index 5) (cps)	(Modulation Index 1) (cps)
1	400	± 30	370	430	6.0	30
2	560	42	518	602	8.4	42
3	730	55	675	785	11.	55
4	960	72	888	1,032	14.	70
5	1,300	98	1,202	1,398	20.	100
6	1,700	128	1,572	1,828	25.	125
7	2,300	173	2,127	2,473	35.	175
8	3,000	225	2,775	3,225	45.	225
9	3,900	293	3,607	4,193	59.	295
10	5,400	405	4,995	5,805	81.	405
11	7,350	551	6,799	7,901	110.	550
12	10,500	788	9,712	11,288	160.	800
13	14,500	1,088	13,412	15,588	220.	1,100
14	22,000	1,650	20,350	23,650	330.	1,650
15	30,000	2,250	27,750	32,250	450.	2,250
16	40,000	3,000	37,000	43,000	600.	3,000
17	52,500	3,940	48,560	56,440	790.	3,950
18	70,000	5,250	64,750	75,250	1,050.	5,250
A*	22,000	3,300	18,700	25,300	660.	3,300
B*	30,000	4,500	25,500	34,500	900.	4,500
C*	40,000	6,000	34,000	46,000	1,200.	6,000
D*	52,500	7,880	44,620	60,380	1,600.	8,000
E*	70,000	10,500	59,500	80,500	2,100.	10,500
*When using Band Omit Bands			A 15 and B	B 14, 16, A and C	C 15, 17, B and D	D 16, 18, C and E

TABLE I FM/FM TELEMETRY: IRIG STANDARD SUBCARRIER BANDS

Channel 1 to 1.05kc for channel 18, or 2.1 kc for channel E. For a modulation index of 1, these intelligence frequencies are multiplied by 5. The frequency capabilities of the IRIG channels are detailed on the above chart.

*Inter-Range Instrumentation Group.

CONSTANT BANDWIDTH MULTIPLEXING

Data-Control Systems, Inc. has developed constant bandwidth channel standards for a 5-channel multiplex, providing equal high frequency intelligence on each channel. The frequency deviation from center frequency is the same for each channel, resulting in a different percentage deviation per channel. The quality of these channels is, of course, related to the ratio of carrier frequency deviation/data bandwidth. This ratio is the Modulation Index. As the Modulation Index is increased the system noise is reduced.

Constant Bandwidth Systems provide identical intelligence capabilities for each channel. As telemetry requirements have progressed, the trend towards higher intelligence frequencies has increased, and time correlation between channels has become an important factor. The utilization of constant percentage deviation IRIG channels with a constant modulation index for all channels results in a different intelligence frequency capability of each channel.

CONSTANT BANDWIDTH RECORDING STANDARDS

DATA SYSTEM	CENTER FREQUENCY (KC)	DEVIATION	INTELLIGENCE	
			MI = 2	MI = 4
Mark 1000	6.25	All ± 1 kc	500cps	250cps
	10.00			
	13.75			
	17.5			
	21.25			
Mark 2000	12.5	All ± 2 kc	1000cps	500cps
	20.0			
	27.5			
	35.0			
	42.5			
Mark 4000	25	All ± 4 kc	2000cps	1000cps
	40			
	55			
	70			
	85			
Mark 8000	50	All ± 8 kc	4000cps	2000cps
	80			
	110			
	140			
	170			
Mark 16,000	100	All ± 16 kc	8000cps	4000cps
	160			
	220			
	280			
	340			

TABLE II and III

High intelligence data is placed on the higher frequency channels, generally 14 through 18, or A, C and E. As the standard filters for these channels are of different bandwidth and cut-off frequencies, the time delay of the intelligence varies widely. Time correlation is often a tedious and time consuming task. In order to record two channels with identical data characteristics, it is necessary to record two similar channels on two separate tape tracks. This procedure is very restrictive, for in today's work, there are many problems where it is necessary to telemeter the output of many identical transducers and also to have time correlation between the data channels.

Constant bandwidth systems achieve these goals. As frequency deviation from center frequency is identical for each channel, identical intelligence data can be multiplexed and recorded on one tape track of 50 kc capability. This would provide 35 channels of 1.0 kc capability on a seven-track tape recorder operating at one-half the speed required for an IRIG multiplex, resulting in twice the recording time per foot of tape.

The limiting factor of constant bandwidth channels is the minimum and maximum percentage of deviation possible. As the percentage becomes large (below the lower channels) non-linearity and presence of subcarrier components in data become problems, and as the percentage becomes small (above the higher channels) drift becomes a problem.

FREQUENCY TRANSLATION

To effectively utilize the full bandwidth capabilities of the tape recorder, additional channels can be multiplexed with the original constant bandwidth series by a method of frequency translation. In this process an identical series of channels is multiplexed and heterodyned to a higher frequency spectrum, then linearly mixed with the original multiplex and transmitted or recorded. This effectively doubles the channel recording capabilities of the tape recorder making it possible to record up to 70 data channels on a 100 kc seven-track magnetic tape recorder, or 140 data channels on a 100kc 14-track tape recorder.

In addition, different constant bandwidth series, or IRIG and constant bandwidth channels can be placed on the same recording track. In playback, the translated multiplex is heterodyned down to its original spectrum position and demodulated through standard demodulation equipment.

Information on the frequency capabilities of the UNIDAP Constant Bandwidth Systems is summarized in table II.

The unique DCS Frequency Translation process is often utilized to provide the advantage of additional channel recording capabilities.



UNIDAP Model GOM-1 Millivolt Controlled Oscillator occupies a single module space. The unit is a fixed channel oscillator, fully transistorized.

The following Technical Specification Sheets, giving full performance specifications and installation characteristics of UNIDAP systems components, are available from any Data-Control Systems representative or branch office without obligation:

SS(GMA-1)-01	Module Assembly
SS(GFD-5)-02	Subcarrier Discriminator
SS(GFD-5/TU)-01	Tuning Unit
SS(GFD-5/TU/L)-01	Low Pass Filter
SS(GFD-5/R)-01	Reference Tuning Unit
SS(GFD-5/TU/LSM)00	Switchable Mode Low Pass Filter
SS(GTC-5)-01	Tape Speed Compensation Unit
SS(GOM-1)-01	Millivolt Controlled Oscillator
SS(GOV-3)-01	Wide Frequency Range Voltage Controlled Oscillator
SS(GOV-3/F)-01	Frequency Unit
SS(GOV-3/FS)-01	Frequency Unit
SS(GXO-1)-01	Crystal Oscillator
SS(GXO-1/F)-01	Frequency Unit
SS(GSA-1)-01	Line Driving Amplifier
SS(GSA-2)-01	Line Driving Amplifier
SS(GFT-4)-01	Frequency Translator
SS(GFT-4/F)-01	Frequency Unit
SS(GFT-6)00	Frequency Translator
SS(GFT-6/F)00	Frequency Unit
SS(GLF-1)-01	Predetection Limiter-Filter
SS(GLF-1/TU)-01	Tuning Unit
SS(GIC-1)-01	Intermediate Frequency Converter
SS(GXO-2)-01	Crystal Oscillator
SS(GXO-2/F)-01	Frequency Unit
SS(GTO-5)-01	Test Oscillator
SS(GMB-1)-01	Module Blank
SS(GVA-1)-01	Voice Annotator
SS(GTF-2)-01	Test Fixture
SS(GTF-3)00	Test Fixture
SS(GCV-3)00	Voltage Calibrator
SS(GSI-1)00	Subcarrier Indicator
SS(GCI-1)00	Compensator Indicator

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HOW TO USE UNIDAP

Figure 1 through 5 illustrate the five principal ways in which the constant bandwidth channels and the IRIG channels can be utilized to meet specific data acquisition requirements. Figure 6 shows typical UNIDAP modular components in the 19 inch by 3½ inch module assembly unit.

The five principal UNIDAP system configurations are illustrated as follows:

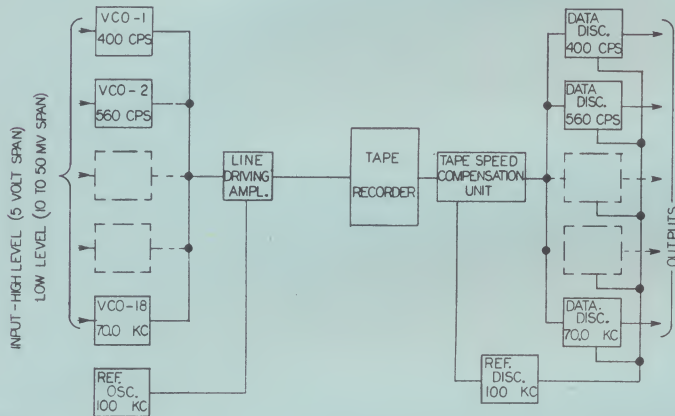


Figure 1. Mark 1 System - Handles standard IRIG frequencies up to 18 data channels (without translation). Frequency spectrum of the FM multiplex; 370 cps to 80,500 cps. Information bandwidth 6 cps to 10,500 cps (depending on modulation index selected).

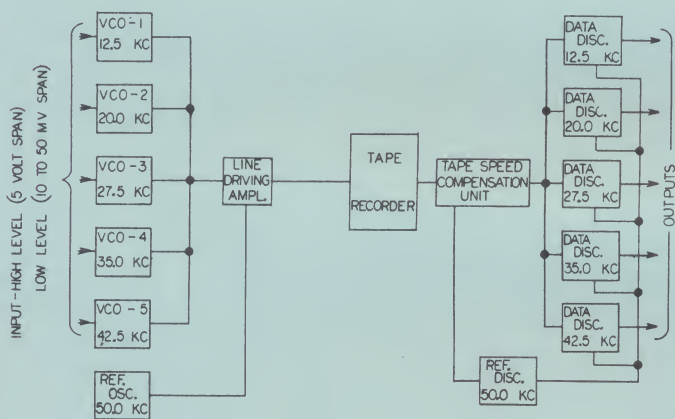


Figure 2. Five-Channel Constant Bandwidth System - The Mark 2000 system with ± 2 kc carrier deviation is shown as an example. The frequency spectrum required for each UNIDAP system, also the intelligence data capability for several modulation indices, are listed in Tables I, II, and III.

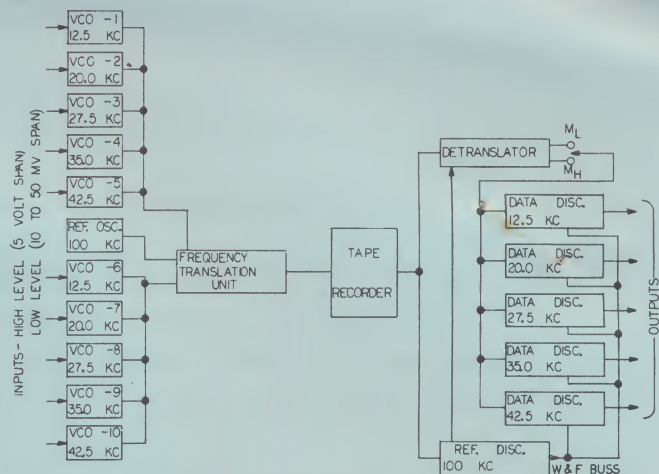


Figure 3. Ten-Channel Constant Bandwidth System - In this system, one of the sets of 5 FM subcarriers is translated to a higher frequency band before recording. The Mark 2000 system with ± 2 kc deviation is shown as an example. The translated multiplex is detranslated at the time of readout.

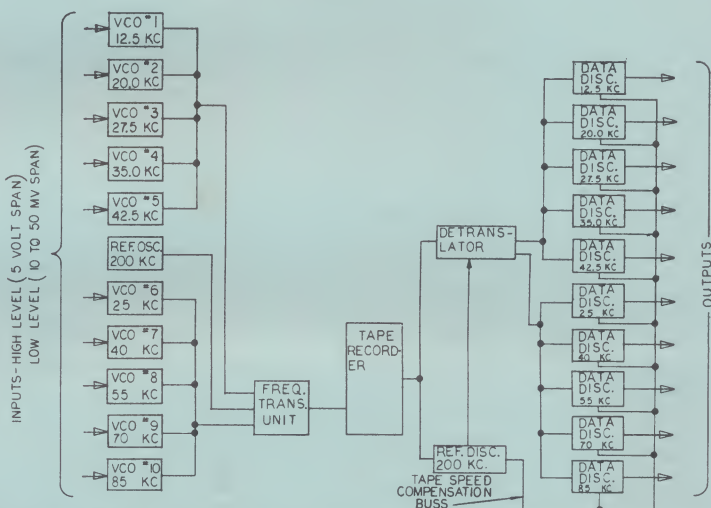


Figure 4. Ten-Channel Constant Bandwidth System - With five channels each of two different carrier deviations. The Mark 2000 system with ± 2 kc deviation, and translated Mark 4000 system with ± 4 kc deviation is illustrated.

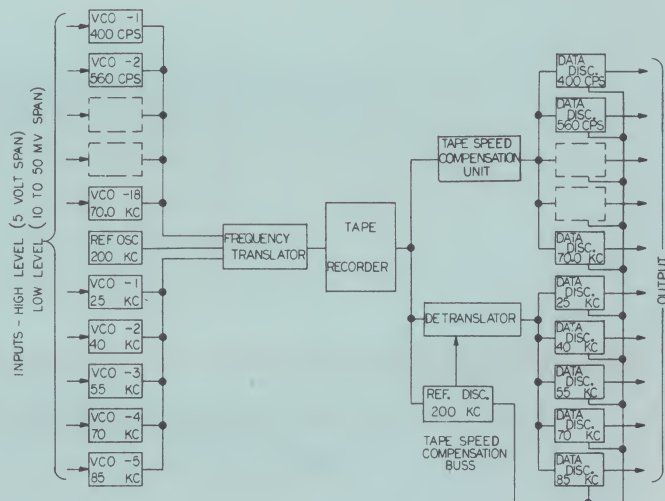


Figure 5. Combination 18-Channel IRIG and 5-Channel Constant Bandwidth System - The system shown will record a complete 18-channel IRIG multiplex, also 5 channels of translated Mark 4000 on one tape track.

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